

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Aggidis *et al.* : Attorney Docket No. 04-40092-US
Serial No.: 10/784,544 : Examiner: TBD
Filed: February 23, 2004 : Group Art Unit: 3746
For: Improvements In Or Relating To Turbines And :
In Particular Pelton Wheel Turbines :

MAIL STOP PETITION
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

**UPDATED PETITION FOR ACCEPTANCE OF UNSIGNED DECLARATION
PURSUANT TO 37 C.F.R. 1.47(a)**

Sir:

Applicant herewith submits its Updated Petition for Acceptance of Unsigned Declaration Pursuant to 37 C.F.R. §1.147(a) in response to the Decision Refusing Status Under 37 C.F.R. §1.147(a), transmitted from the Office on January 21, 2005. A two month deadline for responding to the Decision Refusing Status expired on March 21, 2005, and accordingly a two month petition for extension is submitted herewith.

Remarks

In its Decision Refusing Status Under 37 C.F.R. §1.147(a), the Office refused the previously filed petition, a copy of which is attached hereto as Exhibit A, for failing to satisfy the requirement that the petition show that the non-signing inventor was provided with a copy of the application papers. The Petitions Attorney noted that "Before a refusal can be alleged, applicant must demonstrate [that] a bona fide attempt was made to present a copy of the application papers (specification, including claims, drawings, and oath or declaration) to the non-signing inventor." Finally, in the Decision, it was noted that any reply to the Decision "should only address the deficiencies noted . . ."

BEST AVAILABLE COPY

Presentation of the Specification to Mr. Aggidis

As stated in the further correspondence from Applicant's UK counsel (the "March 23 Letter," a copy of which is attached hereto as Exhibit B), Gordon Gilkes International (hereafter "Gilkes"), the Applicant, has clearly made a bona fide effort to provide Mr. Aggidis with a copy of the application papers, including the specification, claims, drawings, and oath or declaration, and to obtain his signature on the declaration.

Mr. Aggidis has not expressly refused to sign the declaration, but has rather silently failed to provide any response, other than to demand that Gilkes provide him with legal counsel in the matter, and to suggest that he should receive further payment for signing the declaration. Not only has Gilkes and their UK counsel clearly made a bona fide effort to provide Mr. Aggidis with the documents, they have also made bona fide efforts to obtain Mr. Aggidis' signature, knowing that he had the documents.

Mr. Aggidis, the non-signing inventor, was previously the Hydro Development Manager & Director of Gilkes. At the time of the filing of the United Kingdom application, evidenced by the correspondence between Mr. Aggidis and Stuart Cardwell, Gilke's patent counsel (these e-mails are attached hereto as Exhibit C,) Mr. Aggidis was responsible for the application on behalf of Gilkes. Since that time, Mr. Aggidis severed his relationship with Gilkes.

Mr. Aggidis does not assert that the documents have not been presented to him. For instance, in his e-mail correspondence of July 18, 2004 (Aggidis to Millward, a copy of which is attached hereto as Exhibit D,) Mr. Aggidis argues that "the US patent Application document appears to give all possible benefits to Gilkes and all the possible negatives to me . . . *What is my compensation?*" [emphasis added.]

Mr. Aggidis further demanded that Gilkes provide him with a lawyer to counsel him regarding the declaration. As shown in Mr. Millward's e-mail of March 16, 2005 (Millward to Aggidis, a copy of which is attached hereto as Exhibit E,) Mr. Aggidis retained a lawyer, who invoiced Gilkes for his services. In response, Brian Millward of Gilkes simply requested that Mr. Aggidis inform Gilkes of his final decision. Mr. Aggidis did not deign to respond.

In the March 23 Letter, Gilkes, through its counsel Kate Lees, forwarded an additional

copy of all documents, again requesting that Mr. Aggidis sign and return the documents to Ms. Lees. Ms. Lees offered to answer any questions Mr. Aggidis had, and even provided a return envelop for the documents. Ms. Lees requested that Mr. Aggidis return the documents by April 15th, 2005. As of May 16th, 2005, no response has been received from Mr. Aggidis.

Conclusion

Not only has Gilkes made a bona fide effort to provide copies of the documents to Mr. Aggidis, Mr. Aggidis has clearly received the relevant documents. Mr. Aggidis requested that Gilkes provide him with counsel to review the papers, and such counsel was provided. Notwithstanding, Mr. Aggidis has continued to refuse to respond to Gilkes' request for his signature on the declaration. Accordingly, the refusal of the December 20, 2004 petition is traversed, and reconsideration of the refusal to accept Applicant's Petition for Acceptance of Unsigned Declaration Pursuant to 37 C.F.R. 1.47(a) is requested.

The Commissioner is hereby authorized to charge any deficiencies or credit any overpayment to Deposit Account No. 18-0586.

CERTIFICATE OF MAILING UNDER 37 C.F.R. 1.10

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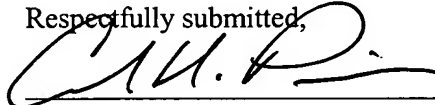
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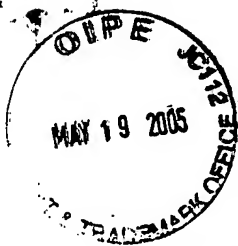
Dolores A. Springfield
(Name of person mailing paper.)

Dolores A. Springfield
Signature of person mailing paper

Respectfully submitted,



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Registration No. 45,730
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Attorney for Applicants



PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Aggidis *et al.* : Attorney Docket No. 04-40092-US
Serial No.: 10/784,544 : Examiner: TBD
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Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

PETITION FOR ACCEPTANCE OF UNSIGNED DECLARATION
PURSUANT TO 37 C.F.R. 1.47(a)

Sir:

Applicant hereby petitions the Commissioner pursuant to 37 C.F.R. § 1.47(a) to accept the Declaration and Power of Attorney submitted herewith (a copy of which is attached hereto as Exhibit A) in accordance with 35 U.S.C. § 118 and in satisfaction of the requirements of the Notice to File Missing Parts which issued in the above identified application on May 18, 2004, (a copy of which is attached hereto as Exhibit B).

Petition under 37 C.F.R. §1.47(a)

37 C.F.R. 1.47(a) provides that "If a joint inventor refuses to join in an application for patent . . . the application may be made by the other inventor on behalf of himself or herself and the non-signing inventor. The oath or declaration in such an application must be accompanied by a petition including proof of the pertinent facts, the fee set forth in §1.17(h), and the last known address of the non-signing inventor. . ."

Underlying Facts

Gilbert Gilkes & Gordon Limited, Canal Head North, Kendal, Cumbria, LA9 7BZ, United Kingdom, is the Applicant for and owner of British Patent Application 0304556.4, a copy of which is attached hereto as Exhibit C. British Patent Application 0304556.4 was filed on February 28, 2003, and identified George Athanasios Aggidis and Robert Catley as the inventors of the invention claimed therein.

On February 23, 2004, the above-identified United States Patent application was filed on behalf of Gilbert Gilkes & Gordon Limited. The United States Application claims priority from

the underlying British application pursuant to 35 U.S.C. § 119(a). A standard declaration and power of attorney for signature by the named inventors was forwarded for signature by Mr. Aggadis and Mr. Catley.

Mr. Catley signed the Declaration on September 16, 2004, identifying both Mr. Aggadis and Mr. Catley as the inventors of the invention claimed in the above-identified United States Patent Application. The Declaration and Power of Attorney signed by Mr. Catley.

Mr. Aggadis and Mr. Catley were employed by Gilbert Gilkes & Gordon Limited when the invention claimed in the preset application was made. Since that time, Mr. Haggadis has left the employ of Gilbert Gilkes & Gordon, Limited.

Efforts have been made by Gilbert Gilkes & Gordon Limited, as well as their attorney in the United Kingdom, to obtain Mr. Aggadis's signature on the Declaration for the above-identified United States Patent Application. As recently as Monday, 20 December 2004, Mr. Aggadis maintained his refusal to sign the Declaration for the above-identified United States Patent Application, although further efforts to obtain his signature continue.

The final extension for responding to the outstanding Notice to File Missing Parts, which issued on May 18, 2004, expires today, December 20, 2004 (with a five month extension,) and accordingly all patent rights in the United States will go abandoned absent satisfaction of the requirements of the Notice to File Missing Parts. Mr. Aggadis's refusal to sign the Declaration will thus irreperably harm both Gilbert Gilkes & Gordon Limited, as well as Robert Catley, by forcing the forfeiture of patent rights in the United States.

Argument

The Manual of Patent Examining Procedure provides that "All the available joint inventors must (1) make oath or declaration on their own behalf as required by 37 C.F.R. 1.63 or 1.175 and (2) make oath or declaration on behalf of the nonsigning joint inventor as required by 37 C.F.R. 1.64. *An Oath or Declaration signed by all the available joint inventors with the signature block of the non-signing inventor(s) left blank may be treated as having been signed by all the available joint inventors on behalf of the nonsigning inventor*, unless otherwise indicated." MPEP §409.03(a) (citations ommitted).

The Declaration and Power of Attorney attached hereto as Exhibit A contains the oath of Mr. Catley on his own behalf as required by 37 C.F.R. § 1.63 (element 1, above), as well as clearly identifies Mr. Aggadis as the joint inventor. Accordingly, Applicant herewith petitions that the Declaration attached hereto as Exhibit A be treated as having been signed by all the available joint inventors on behalf of the nonsigning inventor, pursuant to MPEP § 409.03(a)(A)(2), and that the enclosed Declaration be accepted as pursuant to 35 U.S.C. § 118 and 37 C.F.R. § 1.47(a). Furthermore, the Declaration attached as Exhibit A contains identification of the present address of Mr. Aggadis, 152 Windmere Road, Kendal, Cumbria LA9 5EZ, United Kingdom, in satisfaction of the requirement of 37 C.F.R. 1.47(a), and the petition fee under 37 C.F.R. 1.17(h) is remitted herewith.

Accordingly, applicant requests that submission of the Declaration and Power of Attorney attached hereto as Exhibit A be accepted pursuant to 37 CFR 1.47(a) in satisfaction of the requirement for the named inventors to submit an oath of inventorship pursuant to 35 USC 135 and 37 CFR 1.63, and that the above-identified United States Patent Application be considered complete, and that the application be forwarded for examination.

The Commissioner is hereby authorized to charge any deficiencies or credit any overpayment to Deposit Account No. 18-0586.

CERTIFICATE OF MAILING UNDER 37 C.F.R. 1.10

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Date of Deposit: December 20, 2004

I hereby certify that this paper and/or fee is being deposited with the United States Postal Service, "EXPRESS MAIL - POST OFFICE TO ADDRESSEE" service under 37 C.F.R. 1.10, on the date indicated above, and is addressed to the Commissioner for Patents, P. O. Box 1450, Alexandria, VA 22313-1450

Franziska Reichstein

(Name of person mailing paper.)

F. Reichstein
Signature of person mailing paper.)

Respectfully submitted,

Carl H. Pierce

Registration No. 45,730

REED SMITH LLP

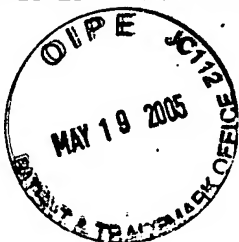
2500 One Liberty Place

1650 Market Street

Philadelphia, PA 19103-7301

(215) 241-7970

Attorney for Applicants



Docket No.: 04-40092-US

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are stated below next to my name.

I believe I am an original, first, and joint inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled:

**IMPROVEMENTS IN OR RELATING TO TURBINES
AND IN PARTICULAR PELTON WHEEL TURBINES**

the specification of which was filed with the United States Patent and Trademark Office on February 23, 2004 and accorded Serial No. 10/784,544.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with 37 CFR §1.56.

I hereby claim foreign priority benefits under 35 U.S.C. §119(a)-(d) or §365(b) of any foreign application(s) for patent or inventor's certificate, or §365(a) of any PCT international application which designated at least one country other than the United States, listed below and have also identified below any foreign application for patent or inventor's certificate or PCT International application having a filing date before that of the application on which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S)

| COUNTRY/OFFICE | APPLICATION NO. | DATE OF FILING | PRIORITY CLAIMED |
|----------------|-----------------|-------------------|---|
| Great Britain | 0304556.4 | February 28, 2003 | <input checked="" type="checkbox"/> YES NO <input type="checkbox"/> |
| | | | <input type="checkbox"/> YES NO <input type="checkbox"/> |

I hereby claim the benefit under 35 U.S.C. §119(e) of any United States Provisional application(s) listed below.

| PROVISIONAL APPLICATION NUMBER | DATE OF FILING |
|--------------------------------|----------------|
| None | |
| | |

Docket No.: 04-40092-US

I hereby claim the benefit under 35 U.S.C. §120 of any United States application(s) or §365(c) of any PCT international application(s) designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of 35 U.S.C. §112, I acknowledge the duty to disclose material information as defined in 37 CFR §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

**PRIOR U.S. APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS
DESIGNATING THE U.S. FOR BENEFIT UNDER 35 U.S.C. §120**

| Application Serial No. | Date of Filing | Status (check one) | | |
|------------------------|----------------|--------------------------|--------------------------|--------------------------|
| | | Patented | Pending | Abandoned |
| None | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

And I hereby appoint Louis M. Heidelberger, Reg. No. 27,899; John W. Goldschmidt, Jr., Reg. No. 34,828; William J. McNichol, Jr., Reg. No. 31,179; Maryellen Feehery, Reg. No. 44,677; Carl H. Pierce, Reg. No. 45,730; Nanda P.B.A. Kumar, Reg. No. 44,853; Thomas J. McWilliams, Reg. No. 44,930; Matthew J. Essemann, Reg. No. 41,536; Jonathan M. Darcy, Reg. No. 44,054; Todd A. Norton, Reg. No. 48,636; Edward P. Belun, Jr., Reg. No. 52,606; Frederick H. Colen, Reg. No. 28,061; Gene A. Tabachnick, Reg. No. 33,801; Maria N. Bernier, Reg. No. 37,433; Barry J. Coyne, Reg. No. 43,566; Kirsten R. Rydstrom, Reg. No. 38,603; Paul D. Bangor, Jr., Reg. No. 34,768; Charles H. Dougherty, Jr., Reg. No. 42,494; Robert D. Kucler, Reg. No. 45,908; Cheryl L. Gastineau, Reg. No. 39,469; Ian K. Samways, Reg. No. 36,664; James Dilmore, Reg. No. 51,618; Marc J. Farrell, Reg. No. 37,826; Stanley P. Fisher, Reg. No. 24,344; Juan Carlos A. Marquez, Reg. No. 34,072; Gerald Kiel, Reg. No. 25,116; Eugene Le Donne, Reg. No. 35,930; Jules Goldberg, Reg. No. 24,408; Lloyd McAulay, Reg. No. 20,423; Arthur Dresner, Reg. No. 24,403; William H. Dippert, Reg. No. 26,723; Stephen Chin, Reg. No. 39,938; Michael I. Wolfson, Reg. No. 24,750; Harry K. Alm, Reg. No. 40,243; Daniel P. Lent, Reg. No. 44,867; and Mary E. Buckles, Reg. No. 31,907 of Reed Smith LLP as my attorneys or agents with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.

Address all correspondence to Louis M. Heidelberger, Esq., Reed Smith LLP, 2500 One Liberty Place, 1650 Market Street, Philadelphia, PA 19103. Address all telephone calls to Louis M. Heidelberger, (215) 851-8100; telefax (215) 851-1420.

Docket No.: 04-40092-US

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

| FULL NAME OF SOLE OR FIRST INVENTOR | | |
|--|--|---|
| <u>George</u> (Given Name) | <u>Athanasios</u> (Middle Initial or Name) | <u>Aggidis</u> (Family or Last Name) |
| Inventor's signature: | | |
| Date: | | |
| Country of Citizenship: | Greece | |
| Residence: | Kendal | United Kingdom |
| | (City) | (State or Foreign Country) |
| Post Office Address: | 152 Windermere Road, Kendal, Cumbria LA9 5EZ, United Kingdom | |
| FULL NAME OF SECOND INVENTOR | | |
| <u>Robert</u> (Given Name) | <u></u> (Middle Initial or Name) | <u>Cadley</u> (Family or Last Name) |
| Inventor's signature: <i>R. Cadley</i> | | |
| Date: <i>16/9/2004</i> | | |
| Country of Citizenship: | Great Britain | |
| Residence: | Kendal | United Kingdom |
| | (City) | (State or Foreign Country) |
| Post Office Address: | 44 Sparrowmire Lane, Kendal, Cumbria LA9 5PX, United Kingdom | |



INVESTOR IN PEOPLE

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Signed

Dated 3 March 2004

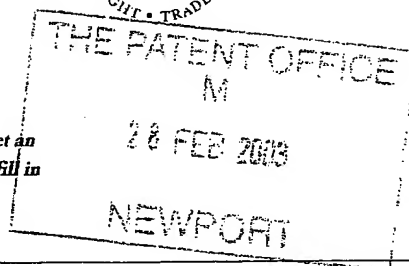
Patent 1977
Rule 10j



28FEB83 1788539.2 000318
P01/770010.00-0304556.4

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)



The Patent Office

Cardiff Road
Newport
South Wales
NP10 8QQ

1. Your reference

SMC/BC/P5159

2. Patent application number

(The Patent Office will fill in this part)

0304556.4

3. Full name, address and postcode of the or of each applicant (underline all surnames)

Gilbert Gilkes & Gordon Ltd
Canal Head North
Kendal
Cumbria, LA9 7BZ

Patents ADP number (if you know it)

If the applicant is a corporate body, give the country/state of its incorporation

UK Wilem 2013 101913

857 5607001

4. Title of the invention

Improvements in or relating to turbines and in particular Pelton wheel turbines

5. Name of your agent (if you have one)

ROYSTONS

"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)

Tower Building
Water Street
Liverpool
L3 1BA

Patents ADP number (if you know it)

1438001 ✓

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (if you know it) the or each application number

Country

Priority application number
(if you know it)

Date of filing
(day / month / year)

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application

Date of filing
(day / month / year)

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer 'Yes' if:

Yes

- a) any applicant named in part 3 is not an inventor, or
 - b) there is an inventor who is not named as an applicant, or
 - c) any named applicant is a corporate body.
- See note (d))

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form

Description 9

Claim(s) 4

Abstract 1

Drawing(s) 242

10. If you are also filing any of the following, state how many against each item.

Priority documents -

Translations of priority documents -

Statement of inventorship and right to grant of a patent (Patents Form 7/77) -

Request for preliminary examination and search (Patents Form 9/77) 1

Request for substantive examination (Patents Form 10/77) -

Any other documents (please specify) -

11. I/We request the grant of a patent on the basis of this application.

Signature

Date

ROYSTONS - Authorised Representative 27/02/2003

12. Name and daytime telephone number of person to contact in the United Kingdom

S.M. Cardwell 0151-236 5147/1417

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

- If you need help to fill in this form or you have any questions, please contact the Patent Office on 08459 500505.
- Write your answers in capital letters using black ink or you may type them.
- If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.
- If you have answered 'Yes' Patents Form 7/77 will need to be filed.
- Once you have filled in the form you must remember to sign and date it.
- For details of the fee and ways to pay please contact the Patent Office.

TITLE : Improvements in or relating to turbines and in particular Pelton wheel turbines.

DESCRIPTION

The present invention relates to an improved construction of turbine rotor and has particular application to a Pelton wheel runner, but without limitation to same.

A Pelton wheel runner comprising a plurality of buckets on a common hub is traditionally made as a single casting. This single casting is usually difficult to cast due to the complexity and proximity of the individual buckets. Following casting, the machining of the Pelton wheel is not the easiest of operations, and the surfaces of the buckets have to be smoothed with a grinding tool. The problem of access for the tool towards the root of the buckets makes the job of finishing a long, expensive and tedious process requiring a high degree of skill.

A Pelton wheel is most usually used to convert the energy of moving water into rotational energy to drive a load. Considerable wear of the buckets can occur and it is common for the wheels to be removed for repair, eg: by a weld repair. If the damaged bucket is beyond weld repair then the whole Pelton runner is scrap.

Proposals have been made in DE 3938357 to construct a Pelton wheel from a plurality of individual segmental elements each formed with a plurality of buckets, and which are assembled together as a unit by securing them between opposed flanged collars by pin means passing through axial holes in the individual segmental elements and by the use of headed bolts whose heads engage with oppositely disposed end caps and whose shanks engage threadingly with the pins to cause the individual segmental elements to be clamped axially between the flanged collars. In addition,

pairs of pin means are provided at the junction of adjacent individual segmental elements to facilitate fine adjustment of the individual segmental elements, and hence the buckets, by way of ball/conical faces. The construction has the disadvantage that it requires many parts, many of which require precision machining, and assembly requires precision fitting.

It is an aim of the present invention to provide an improved construction which provides a solution to these problems and to provide a unique combination of technical (engineering) benefits as well as manufacturing cost savings in relation to a Pelton wheel runner construction.

It is a further aim to provide a beneficial construction of turbine rotor for applications other than that of a Pelton wheel runner.

Accordingly, a first aspect of the present invention provides a turbine rotor having an axis of rotation and comprising a hub or axle element, and a plurality of individual radial body members carrying one or more impeller elements, and wherein the plurality of radial body members are secured with respect to said hub or axle element, each radial body member having leading and trailing radial abutment surfaces relative to the direction of rotation of the rotor that contact with the respective radial abutment surfaces of adjacent radial body members, and each radial body member further comprising at least one further abutment means, and the turbine rotor further comprising locating means in direct or indirect engagement with the further abutment means of the radial body members, and wedging means which is tapered in the radial direction relative to the axis of rotation and which acts between said radial body members and said locating means, and further comprising means

acting via said wedging means to draw the radial body members radially inwards and hold them together as a unit.

The radial body member may be common to a plurality of radially disposed impeller elements, eg: two, three, etc. Preferably the plurality of impeller elements are formed integrally with the associated radial body member, eg: by casting, but they could be secured to the body member by any other positive fixing means. However, in a preferred embodiment each impeller element is formed with its own radial body member. A lost wax investment casting process is preferred. The body members form segments of the rotor and the opposite radial abutment surfaces thereof are tapered so that they converge on and intersect at the axis of rotation.

Preferably the further abutment means comprises axial abutment means. Preferably each radial body member comprises two further abutment means which are disposed to opposite axial ends thereof. Preferably the locating means comprises two locating elements that are engageable with a respective one of the two further abutment means of the radial body members.

The wedging means may be a separate member or members interposed between the further abutment means and the locating means. More preferably the wedging means is incorporated in at least one of the further abutment means or said locating means. Preferably the or each locating means comprises an annular locating ring which is provided with a frusto conical abutment that is co-operable with a respective one of the further abutment means of the radial body members. Preferably the or each further abutment means of each radial body means is radially tapered. Conveniently the tapered abutment means is in the form of a flange extending in the axial direction, and, on assembly, the flanges of all the radial body elements and

hence the impeller elements form an annular (frusto conical) tapered flange that is acted on by the frusto conical abutment of the annular locating ring.

Preferably means is provided for directly securing together the respective pair of locating elements. Said means comprises an axial clamping means and may be used on its own to locate the radial body elements and hence the impeller elements together as a unit by drawing together the two annular locating elements. Means is provided to connect the locating rings with respect to a connecting shaft, eg: the axle element. A shaft key may be used to connect the locating elements to the shaft. Each locating element may have its own key, or one key may be common to both, or only one key used and the clamping means used to connect the keyed element to the non-keyed element. More preferably each of the annular locating rings is connectable individually with a connecting shaft, eg: the axle element. Conveniently the means connecting the or each locating element to the connecting shaft comprises a tapered locking element, such as elements made by the German company Ringfeder or others. In a preferred construction each locating ring is provided with its own tapered locking ring (comprising two relatively moveable parts) which engages between the shaft and the locating ring. The action of tightening the locking element generates an axial movement of the locating ring relative to the shaft and thereby causes the radial body members and hence the impeller elements to be drawn inwardly by virtue of the co-operating tapered abutment surfaces. The provision of radial leading and trailing abutments on the radial body members gives rise to a circumferential wedging action as the radial body members are drawn inwardly by the annular locating rings.

The respective means to locate each annular locating element may be provided in addition to or as an alternative to the aforesaid axial clamping means. Other means of securing the annular locating rings to the axle may be used.

According to a preferred embodiment, the invention provides a turbine rotor having an axis of rotation and comprising a hub or axle element, a plurality of individual radial body members carrying one or more impeller elements, and two annular collars each having a frusto conical abutment surface, and wherein each radial body member comprises a frusto conical tapered flange to opposite ends thereof, the frusto conical tapered flanges to one axial end being co-operable with the frusto conical abutment surface of one annular collar, and the frusto conical tapered flanges to the other axial end being co-operable with the frusto conical abutment surface of the other annular collar, and further comprising means to secure the radial body members with regard to said hub or axle, and means acting via said frusto conical surfaces to draw the radial body members radially inwards.

In a preferred application the turbine rotor is a Pelton wheel runner and the impeller elements are buckets. The invention is described by way of example only hereinafter in relation to its application to a Pelton wheel runner. The use of conical tapered shoulders clamps the buckets by forcing them together, in a simple manner and has the advantage that it uses a minimum number of components and no precision fitting is required.

The present invention will now be described further, by way of example only, with reference to the accompanying drawings; in which:-

Figure 1 is a broken away front view of a Pelton wheel runner embodying the invention,

Figure 2 is a top view of the Pelton wheel runner of Figure 1,

Figure 3 is a partial section of Figure 1, and

Figure 4 is a perspective view of a bucket used in the embodiment of Figures 1 to 3.

Referring to the drawings, a turbine rotor of the type comprising a Pelton wheel runner is described and illustrated. However, whilst the present invention is described by way of example in relation to its application to Pelton wheel runner, it will be apparent to one skilled in the art that it can be applied to other types of turbine rotor, and the protection is not limited to a Pelton wheel runner.

The Pelton wheel runner according to the illustrated embodiment is made of a plurality of individual segments and each segment is formed with one bucket 1 in the described example and are conveniently referred to as bucket segments. The bucket segments are assembled together in a radial disposition relative to an axis of rotation X-X. Eighteen segments each with one bucket are shown in the illustrated example but it will be understood that the number of segments and the number of buckets per segment may vary according to any particular design requirement. In the illustrated embodiment the wheel is adapted to be mounted on a shaft 6.

Each bucket segment has a body 11 which has, in relation to the direction of rotation of the wheel, leading 13 and trailing 15 radial abutment surfaces. In assembling the plurality of bucket segments together to form a runner, the trailing abutment surface of the body of one bucket segment engages with the leading abutment surface of the body of the next adjacent bucket segment. For simplicity the radial abutment surfaces are plain surfaces, but could include ribs and rebates as

desired to limit machining and/or for location purposes. Any ribs or rebates should not inhibit radial movement for locating purposes as described further hereinafter.

The axial end faces of the runner are defined by opposite axial faces 17,19 of the individual bucket segments. The opposite axial faces each include an axially projecting radially tapered abutment 21 which, when the plurality of bucket segments are assembled together define an axially extending radially tapered annular flange 23 or frusto conical shoulder to each axial end of the runner. Each bucket segment body has a radially inwardly directed surface 25.

In the illustrated embodiment the hub of the Pelton wheel runner is defined by two annular elements 26,27 which form part of the impeller element locating means. Each annular element or locating ring has an annular recess 29 to capture the annular flange of the bucket segments. More particularly one annular element 26 has abutment means 31 disposed to engage with the radially tapered abutment 21 of each of the plurality of bucket segments disposed to one axial end thereof, whilst the other annular element 27 has abutment means 33 disposed to engage with the radially tapered abutment 21 of the opposite end of the bucket segment. More particularly each annular element 26,27 has a tapered frusto conical abutment. Preferably the angle of inclination of the respective tapered abutments of the bucket segments and the flange correspond.

First means for securing the two halves of the hub together is provided by a plurality of threaded bolts 35 whose heads 37 are engaged in respective recesses 38 in one of the halves and whose threaded shanks 39 engage with respective threaded holes 41 in the other half. As will be seen from Figure 3 the two annular elements are drawn together in an axial direction by the action of the bolt, thereby drawing the

tapered abutments thereof in to contact with the tapered flanges of the bucket segments. This in turn applies a radially directed clamping force to the bucket segments drawing them radially inwardly. The inward movement is resisted by the co-operating engagement between the radial abutment surfaces of the bucket segments. More preferably, and as detailed in the illustrated embodiment, each of the annular elements has its own tapered clamping element 34,38 by which each is secured individually to the shaft 6. The construction of the tapered locking elements is such that on tightening there is a relative axial movement between the shaft and the annular element. More particularly the tapered clamping element engages positively with the shaft whilst the annular element moves axially with respect thereto. This determines the final clamping force applied to the bucket segments and, where provided in addition to the first clamping means, overrides the action of the first clamping means.

In the illustrated embodiment the clamping bolts 35 are shown on substantially the same diameter as the locking element 38 and inset behind it. In an alternative design the clamping bolts are disposed at a greater radial distance from the axis X-X, closer towards the neck of the buckets, (especially for larger diameter units) and are accessible from one axial end when the element 38 or any alternative fixing element is in position.

By providing tapered flanges to either axial end of the runner relative to its central plane Y-Y and corresponding tapered flanges on both annular elements, the clamping operation will serve to draw the bucket segments uniformly radially inwardly which is desirable for most applications. However in some applications this may be seen as unnecessary and one of the axial ends of the runner may be provided

with a simple abutment surface on each bucket segment that is configured to allow radially inward movement under the action of co-operating tapered abutments of the other axial end of the runner.

CLAIMS

1. A turbine rotor having an axis of rotation and comprising a hub or axle element, and a plurality of individual radial body members carrying one or more impeller elements, and wherein the plurality of radial body members are secured with respect to said hub or axle element, each radial body member having leading and trailing radial abutment surfaces relative to the direction of rotation of the rotor that contact with the respective radial abutment surfaces of adjacent radial body members, and each radial body member further comprising at least one further abutment means, and the turbine rotor further comprising locating means in direct or indirect engagement with the further abutment means of the radial body members, and wedging means which is tapered in the radial direction relative to the axis of rotation and which acts between said abutment means and said locating means, and further comprising means acting via said wedging means to draw the radial body members radially inwards and hold them together as a unit.
2. A turbine rotor as claimed in claim 1 to which the radial body member is common to a plurality of radially disposed impeller elements.
3. A turbine rotor as claimed in claim 2 in which the plurality of impeller elements are formed integrally with the associated radial body member
4. A turbine rotor as claimed in claim 2 in which the plurality of impeller elements are discrete members that are secured to the body member by positive fixing means.

5. A turbine rotor as claimed in claim 1 in which each impeller element is formed with its own radial body member.
6. A turbine rotor as claimed in any one of claims 1 to 5 in which the body members form segments of the rotor and the leading and trailing radial abutment surfaces thereof are tapered so that they converge on and intersect at the axis of rotation.
7. A turbine rotor as claimed in any one of claims 1 to 6 in which the further abutment means comprises axial abutments means.
8. A turbine rotor as claimed in any one of claims 1 to 7 in which each radial body member comprises two of said further abutment means which are disposed to opposite axial ends thereof.
9. A turbine rotor as claimed in claim 8 in which the locating means comprises two locating elements that are engageable with a respective one of the two further abutment means of the radial body members.
10. A turbine rotor as claimed in any one of claims 1 to 9 in which the wedging means may comprise one or more separate members interposed between the further abutment means and the locating means.
11. A turbine rotor as claimed in any one of claims 1 to 9 in which the wedging means is incorporated in at least one of the further abutment means of each of the radial body members or said locating means.
12. A turbine rotor as claimed in any one of claims 1 to 11 in which the or each locating means comprises an annular locating ring which is provided with a frusto conical abutment.

13. A turbine rotor as claimed in any one of claims 1 to 9 or claim 12 when appended in any one of claim 1 to 9 in which the or each further abutment means of each radial body means is radially tapered.
14. A turbine rotor as claimed in claim 13 when dependent on claim 12 in which the radially tapered abutment means is in the form of a flange extending in the axial direction, and, wherein on assembly, the flanges of all the radial body elements form an annular frusto conical tapered flange that is acted on by the frusto conical abutment of the annular locating ring.
15. A turbine rotor as claimed in claim 9 in which means is provided for directly securing together the two locating elements.
16. A turbine rotor as claimed in claim 15 in which the securing means comprises an axial clamping means.
17. A turbine rotor as claimed in any one of the preceding claims in which means is provided to secure the locating means individually to a separate connecting member.
18. A turbine rotor as claimed in claim 17 in which the separate connecting member comprises the axle element.
19. A turbine rotor as claimed in claims 17 or 18 when dependent on claim 12 or any of claims 13 to 16 when dependent on claim 12 in which a respective means is provided to connect the respective locating rings to the connecting member.
20. A turbine rotor as claimed in claim 19 in which said means comprises a tapered locking element.
21. A turbine rotor as claimed in claim 20 in which each locating ring is provided with its own tapered locking ring comprising two relatively moveable parts which

engage between the connecting member and the locating ring and in which at least one locking ring acts to generate an axial movement of the locating ring relative to the connecting member and thereby cause the radial body members and hence the impeller elements to be drawn inwardly by virtue of the co-operating tapered abutment surfaces.

22. A turbine rotor as claimed in any one of claims 17 to 21 when dependent on claim 16 in which the respective means to locate each annular locating element are provided in addition to the aforesaid axial clamping means.

23. A turbine rotor as claimed in any one of the preceding claims in which the turbine rotor is a Pelton wheel runner and the impeller elements are buckets.

24. A turbine rotor constructed and arranged substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

ABSTRACT

A turbine rotor (eg: a Pelton wheel) is described which comprises a plurality of individual radial body members (11) comprising one or more impeller elements (eg: buckets) (1). The radial body members comprises segments which have leading (13) and trailing (15) radial abutment surfaces that contact with the respective radial abutment surfaces of adjacent radial body members when assembled as a unit. Each radial body member comprises at least one further abutment (21), preferably two at opposite axial ends (17,19) thereof, and locating means (26,27) is provided which co-operates with the further abutment means, preferably directly. Wedging means which is tapered in the radial direction relative to the axis of rotation of the turbine rotor, acts between the radial body members and the locating means, and means is provided which acts via said wedging means to draw the radial body members radially inwards to hold them together as a unit.

More particularly the locating means comprises two collars (26,27) which are engageable with a respective one of the axial end abutments (21) of the radial body members, and the wedging means comprises frusto conical formations of the further abutments of the radial body members and the locating means.

The means acting via the wedging means to draw the body members radially inwards comprises axial clamping means (35) operable between the two collars and/or taper action locating means (34,38) securing the two collars to a connecting shaft or axle element (6).

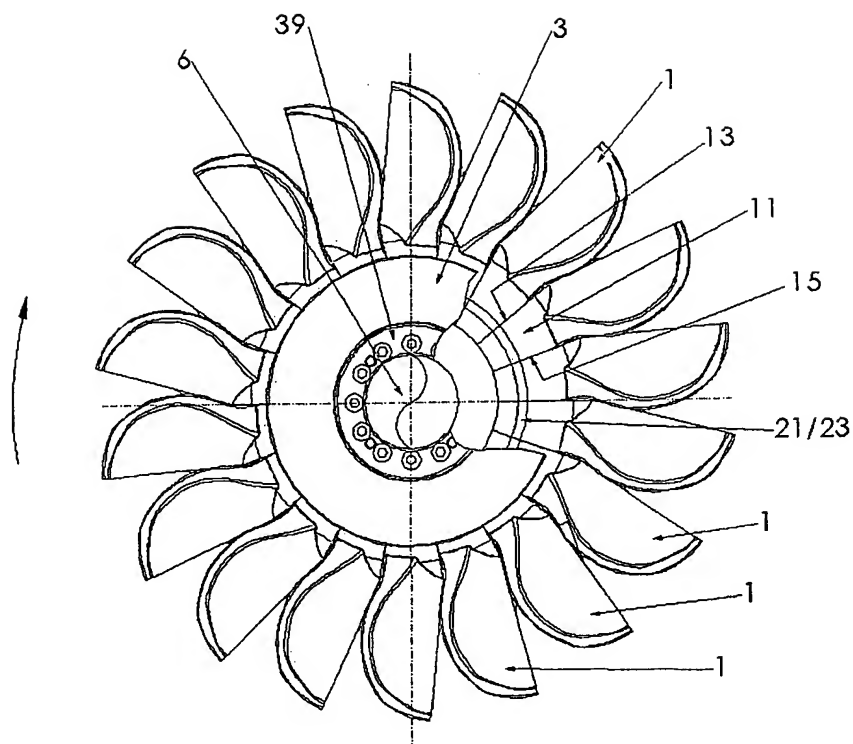


FIGURE 1

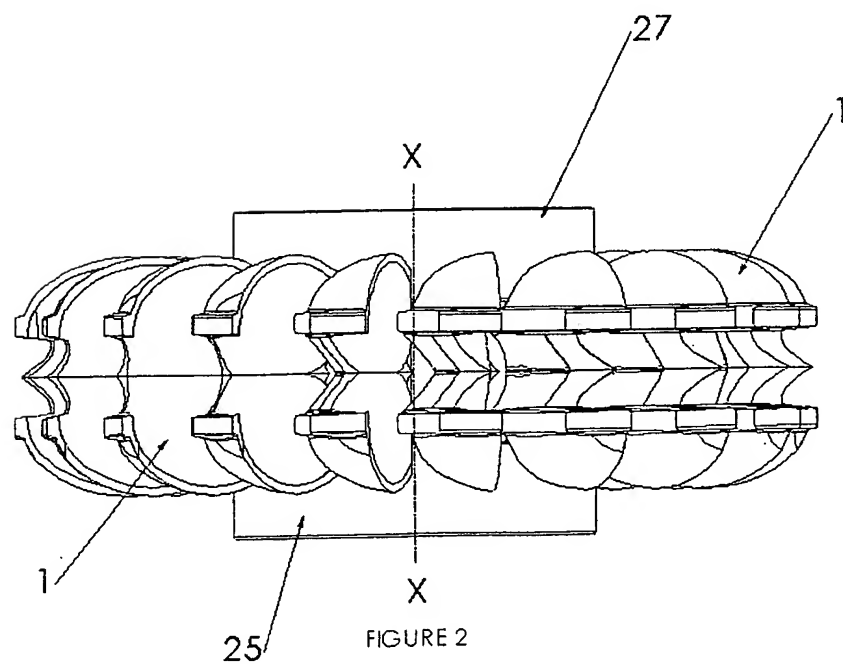


FIGURE 2

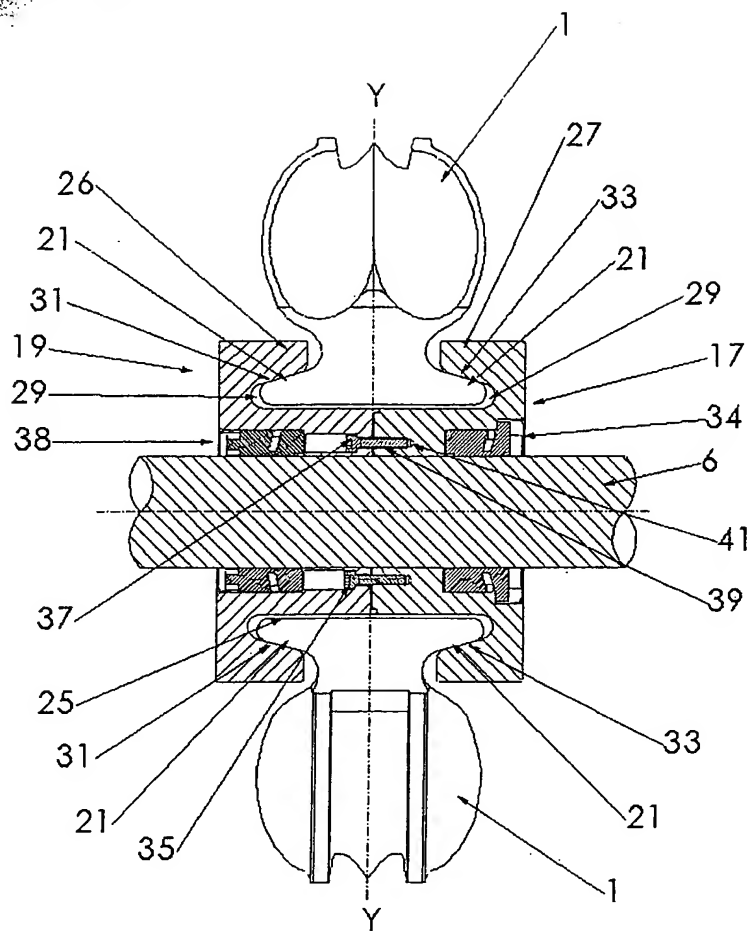


FIGURE 3

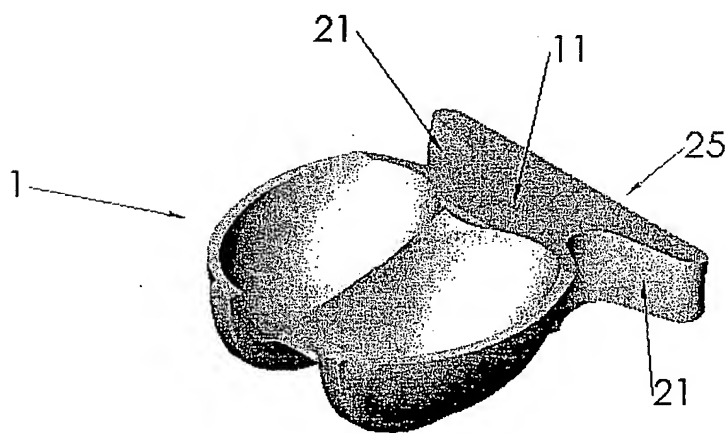


FIGURE 4



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| APPLICATION NUMBER | FILING OR 371 (c) DATE | FIRST NAMED APPLICANT | ATTORNEY DOCKET NUMBER |
|--------------------|------------------------|---------------------------|------------------------|
| 10/784,544 | 02/23/2004 | George Athanasios Aggidis | 04-40092-US-US |

CONFIRMATION NO. 7766

FORMALITIES LETTER

OC000000012701292

07066
 REED SMITH LLP
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 PHILADELPHIA, PA 19103

Date Mailed: 05/18/2004

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

*Filing Date Granted***Items Required To Avoid Abandonment:**

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items and pay any fees required below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The statutory basic filing fee is missing.
Applicant must submit \$ 770 to complete the basic filing fee for a non-small entity. If appropriate, applicant may make a written assertion of entitlement to small entity status and pay the small entity filing fee (37 CFR 1.27).
- The oath or declaration is unsigned.
- To avoid abandonment, a late filing fee or oath or declaration surcharge as set forth in 37 CFR 1.16(e) of \$130 for a non-small entity, must be submitted with the missing items identified in this letter.

The applicant needs to satisfy supplemental fees problems indicated below.

The required item(s) identified below must be timely submitted to avoid abandonment:

- Additional claim fees of \$36 as a non-small entity, including any required multiple dependent claim fee, are required. Applicant must submit the additional claim fees or cancel the additional claims for which fees are due.

SUMMARY OF FEES DUE:

Total additional fee(s) required for this application is ~~\$936~~ for a Large Entity
 1,020.00

- ~~\$770~~ Statutory basic filing fee.
- \$130 Late oath or declaration Surcharge.


- Total additional claim fee(s) for this application is \$36
 100.00

- \$36 for 2 total claims over 20.

100.00

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KJL/CT/P5159

23rd March 2005

Recorded Delivery

Dear Mr. Aggidis

Re: U.S. Patent Application No. 10/784,544
Inventors: George Athanasios Aggidis and Robert Catley
Applicant: Gilbert Gilkes & Gordon Limited
For: Turbines and in particular Pelton Wheel Turbines

I have taken over responsibility for the above case from Stuart Cardwell who has left our firm.

I note that we have not yet received a signed Declaration and Power of Attorney form and Assignment document for submitting in support of the above application.

I believe that you are familiar with the contents of the above application but to ensure that this is indeed the case, I enclose a complete copy of the US patent specification as filed, including a copy of the US claims.

I would be grateful if you could sign and date the attached Declaration and Power of Attorney form and assignment document and return them to me in the return envelope provided before the deadline of **15th April 2005.**

If you have any questions, please do not hesitate to contact me.

Yours sincerely,

Kate J. Lees (Mrs)

MARKS & CLERK

Direct dial +44 151 243 5401

e-mail: klees@marks-clerk.com

Encs

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are stated below next to my name.

I believe I am an original, first, and joint inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled:

**IMPROVEMENTS IN OR RELATING TO TURBINES
AND IN PARTICULAR PELTON WHEEL TURBINES**

the specification of which was filed with the United States Patent and Trademark Office on February 23, 2004 and accorded Serial No. 10/784,544.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with 37 CFR §1.56.

I hereby claim foreign priority benefits under 35 U.S.C. §119(a)-(d) or §365(b) of any foreign application(s) for patent or inventor's certificate, or §365(a) of any PCT international application which designated at least one country other than the United States, listed below and have also identified below any foreign application for patent or inventor's certificate or PCT International application having a filing date before that of the application on which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S)

| COUNTRY/OFFICE | APPLICATION NO. | DATE OF FILING | PRIORITY CLAIMED |
|----------------|-----------------|-------------------|---|
| Great Britain | 0304556.4 | February 28, 2003 | <input checked="" type="checkbox"/> YES NO <input type="checkbox"/> |
| | | | <input type="checkbox"/> YES NO <input type="checkbox"/> |

I hereby claim the benefit under 35 U.S.C. §119(e) of any United States Provisional application(s) listed below.

| PROVISIONAL APPLICATION NUMBER | DATE OF FILING |
|--------------------------------|----------------|
| None | |
| | |

I hereby claim the benefit under 35 U.S.C. §120 of any United States application(s) or §365(c) of any PCT international application(s) designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of 35 U.S.C. §112, I acknowledge the duty to disclose material information as defined in 37 CFR §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

**PRIOR U.S. APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS
DESIGNATING THE U.S. FOR BENEFIT UNDER 35 U.S.C. §120**

| Application Serial No. | Date of Filing | Status (check one) | | |
|------------------------|----------------|--------------------------|--------------------------|--------------------------|
| | | Patented | Pending | Abandoned |
| None | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| | | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

And I hereby appoint Louis M. Heidelberger, Reg. No. 27,899; John W. Goldschmidt, Jr., Reg. No. 34,828; William J. McNichol, Jr., Reg. No. 31,179; Maryellen Feehery, Reg. No. 44,677; Carl H. Pierce, Reg. No. 45,730; Nanda P.B.A. Kumar, Reg. No. 44,853; Thomas J. McWilliams, Reg. No. 44,930; Matthew J. Esserman, Reg. No. 41,536; Jonathan M. Darcy, Reg. No. 44,054; Todd A. Norton, Reg. No. 48,636; Edward F. Behm, Jr., Reg. No. 52,606; Frederick H. Colen, Reg. No. 28,061; Gene A. Tabachnick, Reg. No. 33,801; Maria N. Bernier, Reg. No. 37,433; Barry J. Coyne, Reg. No. 43,566; Kirsten R. Rydstrom, Reg. No. 38,603; Paul D. Bangor, Jr., Reg. No. 34,768; Charles H. Dougherty, Jr., Reg. No. 42,494; Robert D. Kucler, Reg. No. 45,908; Cheryl L. Gastineau, Reg. No. 39,469; Ian K. Samways, Reg. No. 36,664; James Dilmore, Reg. No. 51,618; Marc J. Farrell, Reg. No. 37,826; Stanley P. Fisher, Reg. No. 24,344; Juan Carlos A. Marquez, Reg. No. 34,072; Gerald Kiel, Reg. No. 25,116; Eugene Le Donne, Reg. No. 35,930; Jules Goldberg, Reg. No. 24,408; Lloyd McAulay, Reg. No. 20,423; Arthur Dresner, Reg. No. 24,403; William H. Dippert, Reg. No. 26,723; Stephen Chin, Reg. No. 39,938; Michael I. Wolfson, Reg. No. 24,750; Harry K. Ahn, Reg. No. 40,243; Daniel P. Lent, Reg. No. 44,867; and Mary E. Buckles, Reg. No. 31,907 of Reed Smith LPP as my attorneys or agents with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.

Address all correspondence to Louis M. Heidelberger, Esq., Reed Smith LLP, 2500 One Liberty Place, 1650 Market Street, Philadelphia, PA 19103. Address all telephone calls to Louis M. Heidelberger (215) 851-8100; telefax (215) 851-1420.

TITLE : Improvements in or relating to turbines and in particular Pelton wheel turbines.

DESCRIPTION

The present invention relates to an improved construction of turbine rotor and has particular application to a Pelton wheel runner, but without limitation to same.

A Pelton wheel runner comprising a plurality of buckets on a common hub is traditionally made as a single casting. This single casting is usually difficult to cast due to the complexity and proximity of the individual buckets. Following casting, the machining of the Pelton wheel is not the easiest of operations, and the surfaces of the buckets have to be smoothed with a grinding tool. The problem of access for the tool towards the root of the buckets makes the job of finishing a long, expensive and tedious process requiring a high degree of skill.

A Pelton wheel is most usually used to convert the energy of moving water into rotational energy to drive a load. Considerable wear of the buckets can occur and it is common for the wheels to be removed for repair, eg: by a weld repair. If the damaged bucket is beyond weld repair then the whole Pelton runner is scrap.

Proposals have been made in DE 3938357 to construct a Pelton wheel from a plurality of individual segmental elements each formed with a plurality of buckets, and which are assembled together as a unit by securing them between opposed flanged collars by pin means passing through axial holes in the individual segmental elements and by the use of headed bolts whose heads engage with oppositely disposed end caps and whose shanks engage threadingly with the pins to cause the individual segmental elements to be clamped axially between the flanged collars. In addition,

pairs of pin means are provided at the junction of adjacent individual segmental elements to facilitate fine adjustment of the individual segmental elements, and hence the buckets, by way of ball/conical faces. The construction has the disadvantage that it requires many parts, many of which require precision machining, and assembly requires precision fitting.

It is an aim of the present invention to provide an improved construction which provides a solution to these problems and to provide a unique combination of technical (engineering) benefits as well as manufacturing cost savings in relation to a Pelton wheel runner construction.

It is a further aim to provide a beneficial construction of turbine rotor for applications other than that of a Pelton wheel runner.

Accordingly, a first aspect of the present invention provides a turbine rotor having an axis of rotation and comprising a hub or axle element, and a plurality of individual radial body members carrying one or more impeller elements, and wherein the plurality of radial body members are secured with respect to said hub or axle element, each radial body member having leading and trailing radial abutment surfaces relative to the direction of rotation of the rotor that contact with the respective radial abutment surfaces of adjacent radial body members, and each radial body member further comprising at least one further abutment means, and the turbine rotor further comprising locating means in direct or indirect engagement with the further abutment means of the radial body members, and wedging means which is tapered in the radial direction relative to the axis of rotation and which acts between said radial body members and said locating means, and further comprising means

acting via said wedging means to draw the radial body members radially inwards and hold them together as a unit.

The radial body member may be common to a plurality of radially disposed impeller elements, eg: two, three, etc. Preferably the plurality of impeller elements are formed integrally with the associated radial body member, eg: by casting, but they could be secured to the body member by any other positive fixing means. However, in a preferred embodiment each impeller element is formed with its own radial body member. A lost wax investment casting process is preferred. The body members form segments of the rotor and the opposite radial abutment surfaces thereof are tapered so that they converge on and intersect at the axis of rotation.

Preferably the further abutment means comprises axial abutment means. Preferably each radial body member comprises two further abutment means which are disposed to opposite axial ends thereof. Preferably the locating means comprises two locating elements that are engageable with a respective one of the two further abutment means of the radial body members.

The wedging means may be a separate member or members interposed between the further abutment means and the locating means. More preferably the wedging means is incorporated in at least one of the further abutment means or said locating means. Preferably the or each locating means comprises an annular locating ring which is provided with a frusto conical abutment that is co-operable with a respective one of the further abutment means of the radial body members. Preferably the or each further abutment means of each radial body means is radially tapered. Conveniently the tapered abutment means is in the form of a flange extending in the axial direction, and, on assembly, the flanges of all the radial body elements and

hence the impeller elements form an annular (frusto conical) tapered flange that is acted on by the frusto conical abutment of the annular locating ring.

Preferably means is provided for directly securing together the respective pair of locating elements. Said means comprises an axial clamping means and may be used on its own to locate the radial body elements and hence the impeller elements together as a unit by drawing together the two annular locating elements. Means is provided to connect the locating rings with respect to a connecting shaft, eg: the axle element. A shaft key may be used to connect the locating elements to the shaft. Each locating element may have its own key, or one key may be common to both, or only one key used and the clamping means used to connect the keyed element to the non-keyed element. More preferably each of the annular locating rings is connectable individually with a connecting shaft, eg: the axle element. Conveniently the means connecting the or each locating element to the connecting shaft comprises a tapered locking element, such as elements made by the German company Ringfeder or others. In a preferred construction each locating ring is provided with its own tapered locking ring (comprising two relatively moveable parts) which engages between the shaft and the locating ring. The action of tightening the locking element generates an axial movement of the locating ring relative to the shaft and thereby causes the radial body members and hence the impeller elements to be drawn inwardly by virtue of the co-operating tapered abutment surfaces. The provision of radial leading and trailing abutments on the radial body members gives rise to a circumferential wedging action as the radial body members are drawn inwardly by the annular locating rings.

The respective means to locate each annular locating element may be provided in addition to or as an alternative to the aforesaid axial clamping means. Other means of securing the annular locating rings to the axle may be used.

According to a preferred embodiment, the invention provides a turbine rotor having an axis of rotation and comprising a hub or axle element, a plurality of individual radial body members carrying one or more impeller elements, and two annular collars each having a frusto conical abutment surface, and wherein each radial body member comprises a frusto conical tapered flange to opposite ends thereof, the frusto conical tapered flanges to one axial end being co-operable with the frusto conical abutment surface of one annular collar, and the frusto conical tapered flanges to the other axial end being co-operable with the frusto conical abutment surface of the other annular collar, and further comprising means to secure the radial body members with regard to said hub or axle, and means acting via said frusto conical surfaces to draw the radial body members radially inwards.

In a preferred application the turbine rotor is a Pelton wheel runner and the impeller elements are buckets. The invention is described by way of example only hereinafter in relation to its application to a Pelton wheel runner. The use of conical tapered shoulders clamps the buckets by forcing them together, in a simple manner and has the advantage that it uses a minimum number of components and no precision fitting is required.

The present invention will now be described further, by way of example only, with reference to the accompanying drawings; in which:-

Figure 1 is a broken away front view of a Pelton wheel runner embodying the invention,

Figure 2 is a top view of the Pelton wheel runner of Figure 1,

Figure 3 is a partial section of Figure 1, and

Figure 4 is a perspective view of a bucket used in the embodiment of Figures 1 to 3.

Referring to the drawings, a turbine rotor of the type comprising a Pelton wheel runner is described and illustrated. However, whilst the present invention is described by way of example in relation to its application to Pelton wheel runner, it will be apparent to one skilled in the art that it can be applied to other types of turbine rotor, and the protection is not limited to a Pelton wheel runner.

The Pelton wheel runner according to the illustrated embodiment is made of a plurality of individual segments and each segment is formed with one bucket 1 in the described example and are conveniently referred to as bucket segments. The bucket segments are assembled together in a radial disposition relative to an axis of rotation X-X. Eighteen segments each with one bucket are shown in the illustrated example but it will be understood that the number of segments and the number of buckets per segment may vary according to any particular design requirement. In the illustrated embodiment the wheel is adapted to be mounted on a shaft 6.

Each bucket segment has a body 11 which has, in relation to the direction of rotation of the wheel, leading 13 and trailing 15 radial abutment surfaces. In assembling the plurality of bucket segments together to form a runner, the trailing abutment surface of the body of one bucket segment engages with the leading abutment surface of the body of the next adjacent bucket segment. For simplicity the radial abutment surfaces are plain surfaces, but could include ribs and rebates as

desired to limit machining and/or for location purposes. Any ribs or rebates should not inhibit radial movement for locating purposes as described further hereinafter.

The axial end faces of the runner are defined by opposite axial faces 17,19 of the individual bucket segments. The opposite axial faces each include an axially projecting radially tapered abutment 21 which, when the plurality of bucket segments are assembled together define an axially extending radially tapered annular flange 23 or frusto conical shoulder to each axial end of the runner. Each bucket segment body has a radially inwardly directed surface 25.

In the illustrated embodiment the hub of the Pelton wheel runner is defined by two annular elements 26,27 which form part of the impeller element locating means. Each annular element or locating ring has an annular recess 29 to capture the annular flange of the bucket segments. More particularly one annular element 26 has abutment means 31 disposed to engage with the radially tapered abutment 21 of each of the plurality of bucket segments disposed to one axial end thereof, whilst the other annular element 27 has abutment means 33 disposed to engage with the radially tapered abutment 21 of the opposite end of the bucket segment. More particularly each annular element 26,27 has a tapered frusto conical abutment. Preferably the angle of inclination of the respective tapered abutments of the bucket segments and the flange correspond.

First means for securing the two halves of the hub together is provided by a plurality of threaded bolts 35 whose heads 37 are engaged in respective recesses 38 in one of the halves and whose threaded shanks 39 engage with respective threaded holes 41 in the other half. As will be seen from Figure 3 the two annular elements are drawn together in an axial direction by the action of the bolt, thereby drawing the

tapered abutments thereof in to contact with the tapered flanges of the bucket segments. This in turn applies a radially directed clamping force to the bucket segments drawing them radially inwardly. The inward movement is resisted by the co-operating engagement between the radial abutment surfaces of the bucket segments. More preferably, and as detailed in the illustrated embodiment, each of the annular elements has its own tapered clamping element 34,38 by which each is secured individually to the shaft 6. The construction of the tapered locking elements is such that on tightening there is a relative axial movement between the shaft and the annular element. More particularly the tapered clamping element engages positively with the shaft whilst the annular element moves axially with respect thereto. This determines the final clamping force applied to the bucket segments and, where provided in addition to the first clamping means, overrides the action of the first clamping means.

In the illustrated embodiment the clamping bolts 35 are shown on substantially the same diameter as the locking element 38 and inset behind it. In an alternative design the clamping bolts are disposed at a greater radial distance from the axis X-X, closer towards the neck of the buckets, (especially for larger diameter units) and are accessible from one axial end when the element 38 or any alternative fixing element is in position.

By providing tapered flanges to either axial end of the runner relative to its central plane Y-Y and corresponding tapered flanges on both annular elements, the clamping operation will serve to draw the bucket segments uniformly radially inwardly which is desirable for most applications. However in some applications this may be seen as unnecessary and one of the axial ends of the runner may be provided

with a simple abutment surface on each bucket segment that is configured to allow radially inward movement under the action of co-operating tapered abutments of the other axial end of the runner.

CLAIMS

1. A turbine rotor having an axis of rotation and comprising an axle element, and a plurality of individual radial body members carrying one or more impeller elements, and wherein the plurality of radial body members are secured with respect to said axle element, each radial body member having leading and trailing radial abutment surfaces relative to the direction of rotation of the rotor that contact with the respective radial abutment surfaces of adjacent radial body members, and each radial body member further comprising at least one further abutment means, and the turbine rotor further comprising locating means in one of direct and indirect engagement with the further abutment means of the radial body members, and wedging means which is tapered in the radial direction relative to the axis of rotation and which acts between said abutment means and said locating means, and further comprising means acting via said wedging means to draw the radial body members radially inwards resisted only by contact of the respective adjacent leading and trailing radial abutment surfaces of the body members to hold them together as a unit.
2. A turbine rotor as claimed in claim 1 to which the radial body member is common to a plurality of radially disposed impeller elements.
3. A turbine rotor as claimed in claim 2 in which the plurality of impeller elements are formed integrally with the associated radial body member
4. A turbine rotor as claimed in claim 2 in which the plurality of impeller elements are discrete members that are secured to the body member by positive fixing means.

5. A turbine rotor as claimed in claim 1 in which each impeller element is formed with its own radial body member.
6. A turbine rotor as claimed in claim 1 in which the body members form segments of the rotor and the leading and trailing radial abutment surfaces thereof are tapered so that they converge on and intersect at the axis of rotation.
7. A turbine rotor as claimed in claim 1 in which the further abutment means comprises axial abutments means.
8. A turbine rotor as claimed in claim 1 in which each radial body member comprises two of said further abutment means which are disposed to opposite axial ends thereof.
9. A turbine rotor as claimed in claim 8 in which the locating means comprises two locating elements that are engageable with a respective one of the two further abutment means of the radial body members.
10. A turbine rotor as claimed in claim 1 in which the wedging means comprise at least one separate member interposed between the further abutment means and the locating means.
11. A turbine rotor as claimed in claim 1 in which the wedging means is incorporated in at least one of the further abutment means of each of the radial body members and said locating means.
12. A turbine rotor as claimed in claim 1 in which said at least one locating means comprises an annular locating ring which is provided with a frusto conical abutment.
13. A turbine rotor as claimed in claim 1 in which the at least one further abutment means of each radial body means is radially tapered.

14. A turbine rotor as claimed in claim 13 when dependent on claim 12 in which the radially tapered abutment means is in the form of a flange extending in the axial direction, and, wherein on assembly, the flanges of all the radial body elements form an annular frusto conical tapered flange that is acted on by the frusto conical abutment of the annular locating ring.
15. A turbine rotor as claimed in claim 9 in which means is provided for directly securing together the two locating elements.
16. A turbine rotor as claimed in claim 15 in which the securing means comprises an axial clamping means.
17. A turbine rotor as claimed in claim 1 in which means is provided to secure the locating means individually to a separate connecting member.
18. A turbine rotor as claimed in claim 17 in which the separate connecting member comprises the axle element.
19. A turbine rotor as claimed in claim 17 in which said means comprises a tapered locking element.
20. A turbine rotor as claimed in claim 19 in which each locating ring is provided with its own tapered locking ring comprising two relatively moveable parts which engage between the connecting member and the locating ring and in which at least one locking ring acts to generate an axial movement of the locating ring relative to the connecting member and thereby cause the radial body members and hence the impeller elements to be drawn inwardly by virtue of the co-operating tapered abutment surfaces.

21. A turbine rotor as claimed in claim 17 when dependent on claim 16 in which the respective means to locate each annular locating element are provided in addition to the aforesaid axial clamping means.
22. A turbine rotor as claimed in claim 1 in which the turbine rotor is a Pelton wheel runner and the impeller elements are buckets.

Abstract of the Disclosure

A turbine rotor (eg: a Pelton wheel) is described which comprises a plurality of individual radial body members (11) comprising one or more impeller elements (eg: buckets) (1). The radial body members comprises segments which have leading (13) and trailing (15) radial abutment surfaces that contact with the respective radial abutment surfaces of adjacent radial body members when assembled as a unit. Each radial body member comprises at least one further abutment (21), preferably two at opposite axial ends (17,19) thereof, and locating means (26,27) is provided which co-operates with the further abutment means, preferably directly. Wedging means which is tapered in the radial direction relative to the axis of rotation of the turbine rotor, acts between the radial body members and the locating means, and means is provided which acts via said wedging means to draw the radial body members radially inwards to hold them together as a unit.

More particularly the locating means comprises two collars (26,27) which are engageable with a respective one of the axial end abutments (21) of the radial body members, and the wedging means comprises frusto conical formations of the further abutments of the radial body members and the locating means.

The means acting via the wedging means to draw the body members radially inwards comprises axial clamping means (35) operable between the two collars and/or taper action locating means (34,38) securing the two collars to a connecting shaft or axle element (6).

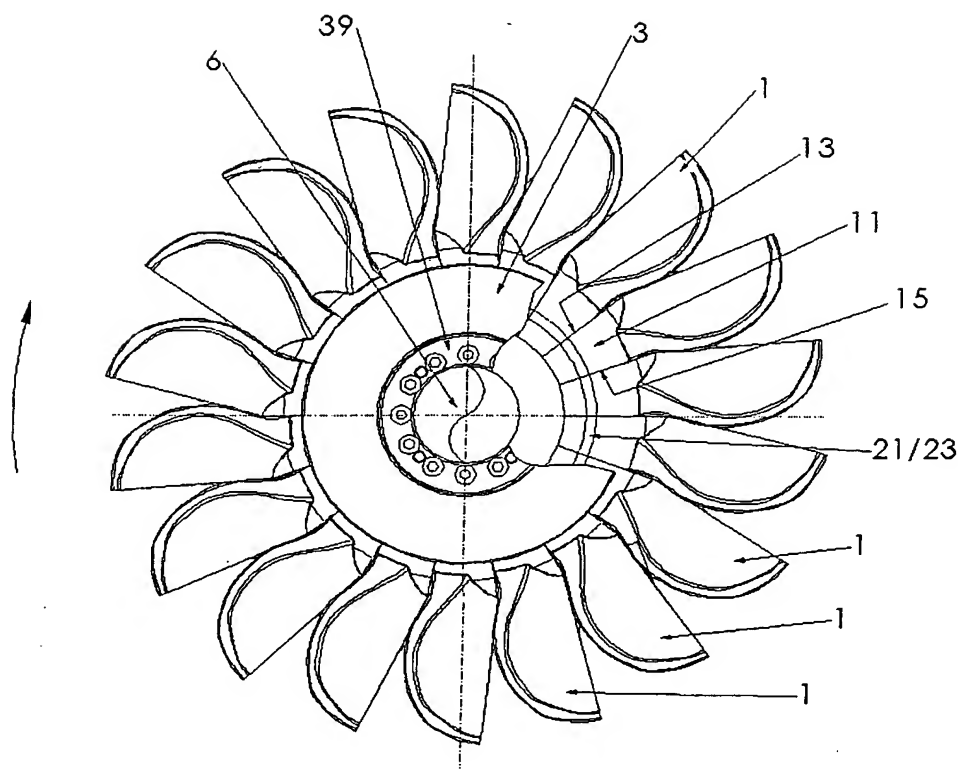


FIGURE 1

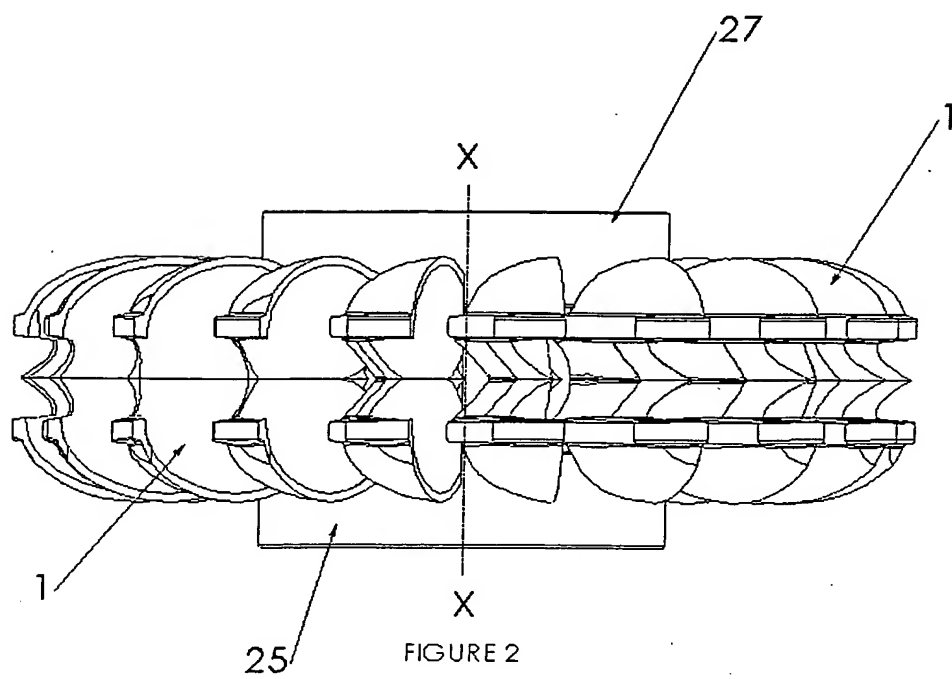


FIGURE 2

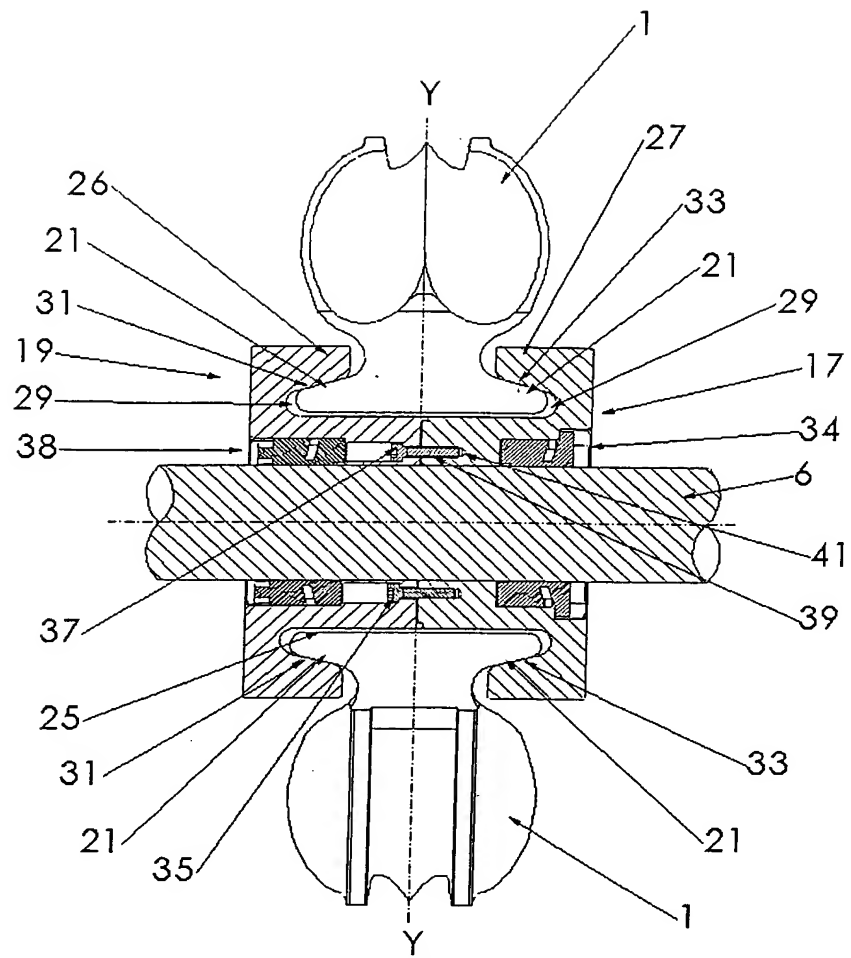


FIGURE 3

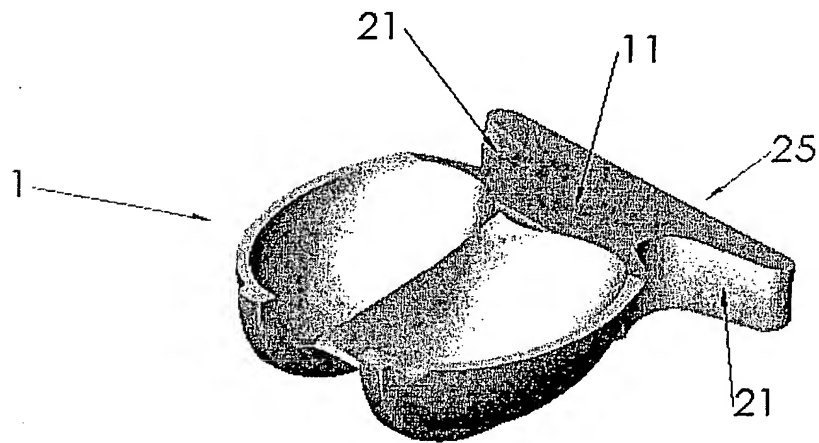


FIGURE 4

Cardwell, Stuart M

From: George Aggidis [g.aggidis@gilkes.com]
Sent: 24 February 2003 16:45
To: g.aggidis@gilkes.com; Cardwell, Stuart M
Subject: Proposed Patent Application for the Pelton Wheel Runner Construction

Deart Mr Cardwell,

Further to your letter dated 18th February 2003 on the above mentioned subject.

I have already send you by mail on the 19th February 2003 following our telephone conversation all the available relevant information on the Patent Search we carried out at the onset of this project.

Gilkes invention uses conical tapered shoulders, clamping the buckets by forcing them together, instead of forcing them apart, is simple, with minimum number of components used, and no precision fitting is required.

Regarding the Draft "Improvements in or relating to turbines and in particular Pelton Wheel Turbines" I could make the following comment:
Page 1 - Lines 11 and 12 "The nature of the repairs is frequently such that the wheels are unbalanced after repair, which means that the wheels have to be discarded" should be deleted.

I have asked also our draughtsman to produce a copy of the 4 figures with the relevant numbers today and I hope to email them to you later today.

Looking forward to receive the final draft copy next Thursday morning, so it could be filed by Friday 28th February 2003 according to your time plan.

Best regards,
George Aggidis

-----Original Message-----

From: George Aggidis [mailto:g.aggidis@gilkes.com]
Sent: 14 February 2003 09:12
To: Cardwell, Stuart M
Subject: RE: Proposed Patent Application for the Pelton Wheel Runner Construction

Dear Mr Cardwell,

Please find attached a compressed word file with the drawing showing the front view but with part of the flange broken away to show the tepered configuration on a number of individual buckets.
I hope I have interpreted correctly your requirement but if you require any modification or additional information or clarification please do not hesitate to contact me.

Best regards,
George Aggidis

-----Original Message-----

From: Cardwell, Stuart M [mailto:Stuart@Roystons.co.uk]
Sent: 13 February 2003 15:16
To: g.aggidis@gilkes.com
Subject: RE: Proposed Patent Application for the Pelton Wheel Runner Construction

Dear Mr Aggidis

I am pleased to report that I have been able to open the drawing file. It

would be useful to have a view based on that of sheet 4 (front view?), but with part of the flange broken away to show the tapered configuration of two or three of the individual buckets. Is that possible?

Regards

Stuart M Cardwell
Roystons

-----Original Message-----

From: George Aggidis [mailto:g.aggidis@gilkes.com]
Sent: 13 February 2003 12:35
To: Cardwell, Stuart M
Subject: RE: Proposed Patent Application for the Pelton Wheel Runner Construction

Dear Mr Cardwell,

Further to your email below and our telephone conversation, please find attached a word document that contains all the 2 D drawings I have attached on my previous email as autocad files.

I hope these drawings are satisfactory for the Patent Application, but if you require any additional format, information or clarification, please do not hesitate to contact me.

I will sent the terms of engagement letter by post.

Best regards,
Eur. Ing. George A. Aggidis
Hydro Development Manager &
Director Gilkes International Ltd
Gilbert Gilkes & Gordon Ltd
Tel: ++44 720 028
Fax: ++44 732 110
Website: www.gilkes.com

-----Original Message-----

From: Cardwell, Stuart M [mailto:Stuart@Roystons.co.uk]
Sent: 13 February 2003 09:47
To: g.aggidis@gilkes.com
Subject: RE: Proposed Patent Application for the Pelton Wheel Runner Construction

Dear Mr Aggidis

Thank you for the e mail. Please let me know what program I should use to open the drawing files.

In addition, please arrange to have our terms of engagement letter signed and returned to me.

Yours sincerely

Stuart M Cardwell
Roystons

-----Original Message-----

From: George Aggidis [mailto:g.aggidis@gilkes.com]
Sent: 12 February 2003 18:13
To: Cardwell, Stuart M
Subject: Proposed Patent Application for the Pelton Wheel Runner Construction

Dear Mr Cardwell,

Further to our meeting in Kendal, your letter dated 29th January 2003 and our subsequent telephone conversation yesterday, I am pleased to inform you that Gilkes Management have agreed to file a patent for the UK only at the

moment to give Gilkes protection from disclosure by the DTI. The deadline for our submission of final report on this project to the DTI as I have already mentioned to you is the 28th February 2003. The total costs involved for the UK patent only as you have explained to me are estimated to be £2,000. In the future we could possibly extend the patent to an additional 10 countries with an estimated average cost per country of £2,000.

Please find attached the following information / drawings that will assist you with the filing of this UK patent:

- 1) A word file called "New Design Pelton 3D drawings" showing the pelton bucket design and its clamping method
- 2) Autocad 2 D drawings of this assembly, Section (with and without seal plates, which is most appropriate to use?) , Front and Top View
- 3) A word document called "Some Notes on the New Pelton Development".

Could you please proceed with the necessary work relating to this Patent Application.

I will be more than pleased to assist in any way possible if further information or clarifications are required.

Best regards,

Eur. Ing. George A. Aggidis
Hydro Development Manager &
Director Gilkes International Ltd
Gilbert Gilkes & Gordon Ltd
Tel: ++44 720 028
Fax: ++44 732 110
Website: www.gilkes.com

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This message has been checked for all known viruses by the MessageLabs Virus Control Centre.

Lees, Kate J

From: Eur. Ing. George A. Aggidis [george@aggidis.freemove.co.uk]
Sent: 18 July 2004 08:02
To: Brian Millward
Cc: George Aggidis (LU)
Subject: Gilkes - USA Patent Application Forms

Dear Brian,

Further to our two and a half hours meeting last Thursday, 15th July 2004, at 8.00 pm at my home, I would also like to summarise the main points and actions discussed as follows:

- 1) I wish all the best for Gilkes, but without jeopardising my own position.
- 2) The US patent application document appears to give all the possible benefits to Gilkes and all the possible negatives to me, the named inventor that I am asked to sign the document.
- 3) Gilkes obviously benefit from this action, what is my own benefit by signing this document?
- 4) There is a point on this form that states that I am adequately compensated for signing this document. What is my compensation?
- 5) There is a requirement for myself to answer any points the patent application examiners raise. This requires my own time and effort that could potentially be unlimited. How am I compensated for this?
- 6) The document needs correcting on the point that mentions citizenship. I am a Greek Citizen.
- 7) The document mentions my responsibility against the law, and punishment with a fine and possible imprisonment, when I sign this document. I am not happy with this point.
- 8) A lawyer might possibly suggest additional documents to be signed to cover relative responsibilities and benefits.
- 9) As a named inventor I would like to receive a copy of all the patent applications made by Gilkes worldwide up to date and in the future.
- 10) These are only some of the points that I noticed but I am an engineer and not a lawyer. My request is for Gilkes to pay for myself to appoint a lawyer that will oversee this document and its signing in order not only to be completely legal and to the letter of the law but also completely fair and balanced to both parties involved.

Looking forward to your response.

Kind regards,
George

Eur. Ing. George A. Aggidis
"Stenkrith", 152 Windermere Road
Kendal, Cumbria, LA9 5EZ, UK
Tel. / Fax. : 01539 720462
Mobile: 07813697630
email: george@aggidis.freemove.co.uk

Lees, Kate J

From: Brian Millward [b.millward@gilkes.com]
Sent: 16 March 2005 17:52
To: 'Aggidis, George'; Eur. Ing. George A. Aggidis
Subject: RE: Patent Application

Dear George,

We have had an invoice in from Pannone for £200+VAT, and I presume that this is for the advice they gave you concerning the USA Patent application documents. We can settle this directly if you wish. For the records I would like a very brief note from yourself confirming your final decision and reasoning related to the signing of the USA patent application documents.

Regards,

Brian

-----Original Message-----

From: Aggidis, George [mailto:g.aggidis@lancaster.ac.uk]
Sent: 16 December 2004 16:43
To: b.millward@gilkes.com
Cc: paula.james@pannone.co.uk
Subject: RE: Patent Application

Dear Brian,

Further to your email and suggestion today, I have contacted Paula James from Pannone and wait for their advice.

Kind regards,
George

Eur. Ing. George A. Aggidis
BEng(Hons), MSc, CEng, FIMechE, REng, GTC(TEE), MASME
Senior Lecturer in Engineering
Director Lancaster University Renewable Energy Group
Director Lancaster University Fluid Machinery Group
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United Kingdom
Tel: +44 (0) 1524 593 052
Fax: +44 (0) 1524 592 777
Mobile: +44 (0) 7813697630
Email: g.aggidis@lancaster.ac.uk
Website: www.lancs.ac.uk & www.engineering.lancs.ac.uk

From: Brian Millward [mailto:b.millward@gilkes.com]
Sent: Thursday, December 16, 2004 10:18 AM
To: Aggidis, George
Subject: Patent Application

George,

As discussed, Gilkes are prepared to reimburse you up to £200 (receipt required) for the services of a Patent Attorney to provide you with advice over the signing of the USA Patent Application for the segmented runner.

We need the signed document returned by tomorrow at the latest in order to proceed with the USA

17/03/2005

application. If we miss this deadline, there is no further extension allowed.
Hope that we can finally get this sorted...

Best regards,

Brian Millward
Engineering Director
Gilbert Gilkes & Gordon Ltd

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